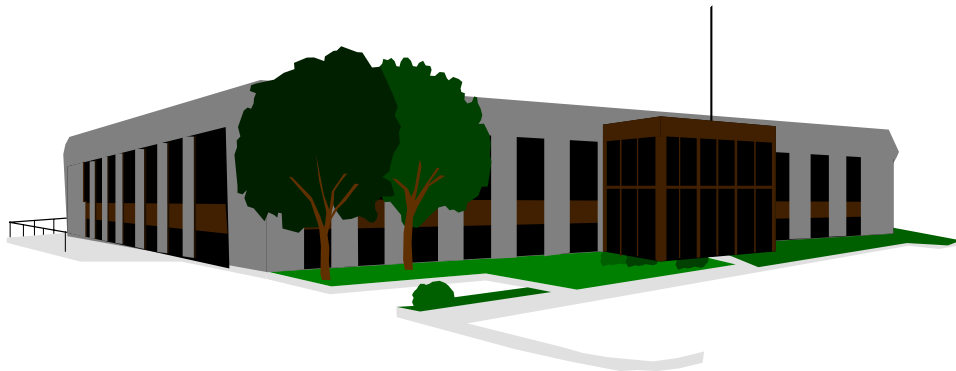


INDOOR AIR QUALITY REASSESSMENT

**Gordon Mitchell Middle School
435 Central Street
East Bridgewater, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
July, 2000

Background/Introduction

At the request of Dick Achin, Assistant Superintendent of the East Bridgewater school system, an indoor air quality assessment was conducted at the Gordon Mitchell Middle School in East Bridgewater, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

The school was originally visited by Michael Feeney, Chief of BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, on November 7, 1997. A report was issued (MDPH, 1997) which described the conditions of the building at that time. The report showed that there were problems identified and gave recommendations on how to correct those problems. This assessment followed the completion of a new wing. The next phase of operations was reported to be the renovation of the old wing. Since the building had undergone renovations, the conditions described in the BEHA 1997 report would be expected to be different.

On March 28, 2000, a visit was made to this school by Cory Holmes, Environmental Analyst, ER/IAQ, BEHA to conduct an indoor air quality assessment. Mr. Achin, Allen Duarte, Principal, Mitchell Middle School and William Robertson, Head Custodian accompanied Mr. Holmes for portions of the assessment. Mr. Holmes returned to the school on April 25, 2000 to take photos of the school's ventilation system.

The school consists of two sections: the old wing constructed in 1968 and an addition, which was occupied in February of 1997. The addition of the new wing forms an enclosed courtyard. The school contains general classrooms, gymnasium, media center, auditorium, music room, woodshop, kitchen, cafeteria and office space.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with a Mannix, TH Pen PTH 8708 Thermo-Hygrometer. Wind speed and direction were measured with a Davis, Wind Wizard, Wind Speed Indicator.

Results

The school houses grades 4-8 with a student population of approximately 900 and a staff of approximately 80. The tests were taken during normal operating hours at the school. Test results appear in Tables 1-6.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in thirty-seven of forty-six areas surveyed, which is indicative of an overall ventilation problem in this school. Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Pictures 1 & 2). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 3) and return air through an air intake located at the base of each unit (see [Figure 1](#)). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were deactivated in a number of classrooms surveyed. BEHA staff were able to activate several of these units using univent power switches (see Tables).

Obstructions to airflow, such as books, papers and posters on top of univents, as well as bookcases, tables and desks in front of univent returns, were seen in a number of classrooms. To function as designed, univents and univent returns must remain free of obstructions. Importantly, these units must be activated and allowed to operate during hours of school occupation.

The mechanical exhaust ventilation system in the 1968 wing consists of wall-mounted exhaust vents (see Picture 4). As with the univents, a number of exhaust vents were obstructed by tables, chairs, boxes and other items (see Picture 5). In addition, many of these vents are located on walls behind cabinets. This design obstructs airflow into the exhaust vents and degrades the efficiency of the system to remove environmental pollutants that commonly build-up indoors. Slotted spaces were cut into the baseboard of cabinets in front of these vents in an attempt to facilitate airflow (see Picture 6).

Exhaust ventilation in the 1997 addition classrooms is provided by vents located in the upper portions of storage closets (see Picture 7). Classroom air is drawn into the coat closet via a passive vent mounted on the lower portion of the closet door (see Picture 8). This design allows for the vents to be easily blocked by stored materials. None of these vents were noted to be drawing air during the assessment. Each exhaust vent is equipped with dampers/flues (see Picture 9), which were closed in numerous cases. Closed dampers inhibit airflow of stale air from the classroom into the exhaust system. In order to function properly, these vents must be clear and remain free of obstructions. BEHA staff recommended to school officials that they contact the architect and/or their HVAC consultant regarding the proper function of this system.

Ceiling mounted or rooftop air handling equipment provides mechanical ventilation for science rooms, computer rooms and common areas (e.g., gym, cafeteria,

auditorium, etc.). The cafeteria and gymnasium ventilation systems were deactivated while these areas were occupied. In addition, exhaust vents for the first floor faculty restrooms and second floor boy's room were not functioning during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 70° F to 79° F, which was close to the BEHA recommended range for comfort. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature complaints were reported to BEHA staff in a number of areas. Temperature control is difficult without a properly functioning ventilation system. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building ranged from 39 to 52 percent. Most areas sampled were within the BEHA recommended comfort range. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The assessment occurred on a day of heavy precipitation (background outdoor relative humidity - 92%). With the combination of inactive ventilation systems and open exterior doors and windows, relative humidity levels can become elevated indoors. While temperature is mainly a comfort issue, relative humidity in excess of 70% can provide an environment for mold and fungal growth (ASHRAE, 1989).

During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed to keep moisture out; in addition, univents and exhaust ventilation should be activated to control moist air in this building. Relative

humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas had water stained ceiling tiles (see Tables/Picture 10). Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered and repaired. Mold can be an eye and respiratory irritant to certain sensitive individuals. The boy's restroom on the first floor contained a water-stained ceiling tile with possible mold growth.

Plants were noted in several classrooms. Plants can be a source of pollen and mold, which can be a respiratory irritant to some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold.

Along the perimeter of the building (and interior courtyard), univent fresh air intakes were noted close to ground level (see Picture 11). Care should be taken to ensure that fresh air intakes remain clear of obstructions (e.g., snow, shrubbery, etc.) to avoid the entrainment of dirt, moisture, pollen and/or other particulate matter.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can become easily aerosolized and serve as an eye and respiratory

irritant. Several areas also had open utility holes and/or dislodged ceiling tiles (see Picture 10/Tables). Open utility holes can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors. The movement of ceiling tiles can introduce dirt, dust and particulate matter into occupied areas of the school. These materials can be irritating for certain individuals.

Cleaning products were observed in several areas. Cleaning products contain chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

A noticeable odor of wood dust was detected in the hallway outside of the wood shop. A space was noted beneath the wood shop door, which can allow dusts/odors to migrate into adjacent areas of the school.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999). Classroom 107 contained a dry erase board mounted over the univent air diffuser. This configuration will allow dry erase board marker odors to be pulled into the air stream and be distributed throughout the classroom. These products can be irritating to the eyes, nose and throat.

The consumer science room contained two gas stoves without local exhaust hoods. Without local exhaust ventilation, combustion by-products (e.g., carbon monoxide) as well as grease, moisture and cooking odors can buildup in the room.

As mentioned previously, mechanical exhaust ventilation in some restrooms was not functioning during the assessment. Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

The teacher's workroom contains a lamination machine and photocopiers (see Picture 12). Lamination machines give off odors. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
3. Inspect exhaust motors and belts for proper function, repair and replace as necessary. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the proper function of exhaust ventilation in the 1997 addition.
4. Remove all blockages from univents and exhaust vents. Examine the feasibility of reconfiguring exhaust vents obstructed by cabinets.

5. Once both the fresh air supply and exhaust ventilation are functioning, the ventilation system should be balanced by an HVAC engineer.
6. Repair and/or replace thermostats as necessary to maintain control of comfort.
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Repair roof/plumbing leaks. Replace any remaining water-stained ceiling tiles and pipe insulation. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
9. Keep plants away from univents in classrooms. Ensure plants have drip pans and examine drip pans for mold growth and disinfect areas with an appropriate antimicrobial where necessary.
10. Replace missing ceiling tiles and fill utility holes to prevent the egress of dirt, dust and particulate matter between rooms and floors.
11. Install weather-stripping on woodshop door to prevent woodshop odors/dusts from penetrating into adjacent areas of the school. Do not conduct wood shop activities with the hallway door open during hours of school occupancy.
12. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.

13. Relocate dry erase board in classroom 107 away from the univent fresh air diffuser.
14. Change or clean filters for univents and air handling units (AHUs) as per the manufacture's instructions or more frequently as needed to prevent the re-aerosolization of dirt, dust and particulate matter.
15. Repair/restore exhaust ventilation for restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.
16. Examine the feasibility of providing local exhaust ventilation for gas stoves in the consumer science area.
17. Ensure exhaust ventilation is functioning in areas that contain lamination machines and photocopiers.

References

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- Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.
- SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0
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Picture 1



Classroom Unit Noted in 1997 Addition

Picture 2



Classroom Univent in 1968 Wing Please Note These Units Appear to be Original Equipment

Picture 3



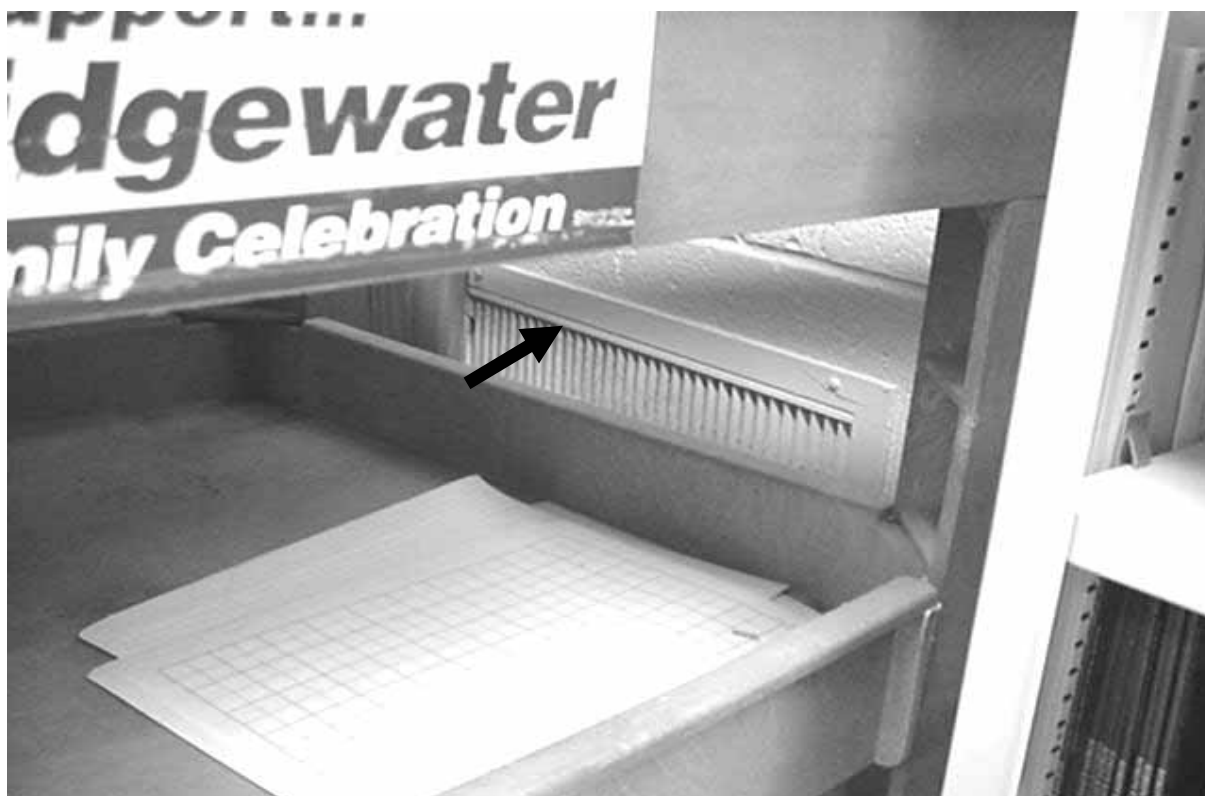
Exterior Wall-Mounted Univent Fresh Air Intake

Picture 4



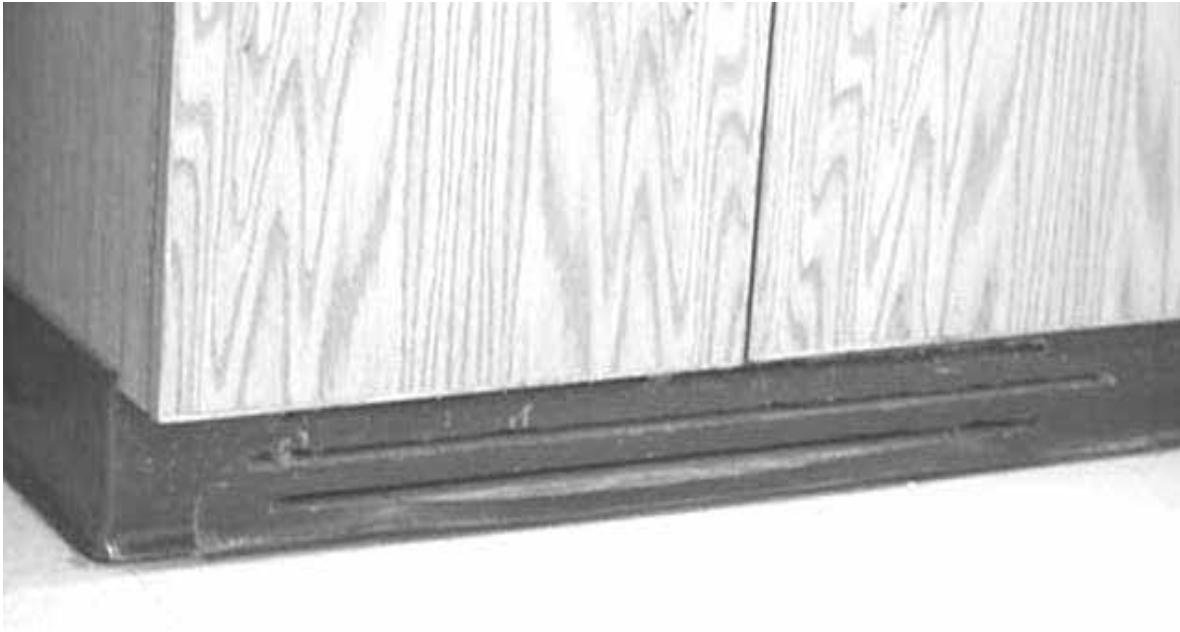
Wall-Mounted Classroom Exhaust Vent Noted in 1968 Wing

Picture 5



Exhaust Vent Obstructed by Cart

Picture 6



**Slotted Holes in Cabinet Baseboard to Provide Exhaust Ventilation
Note Exhaust Vent is Located on Wall Behind Cabinet**

Picture 7



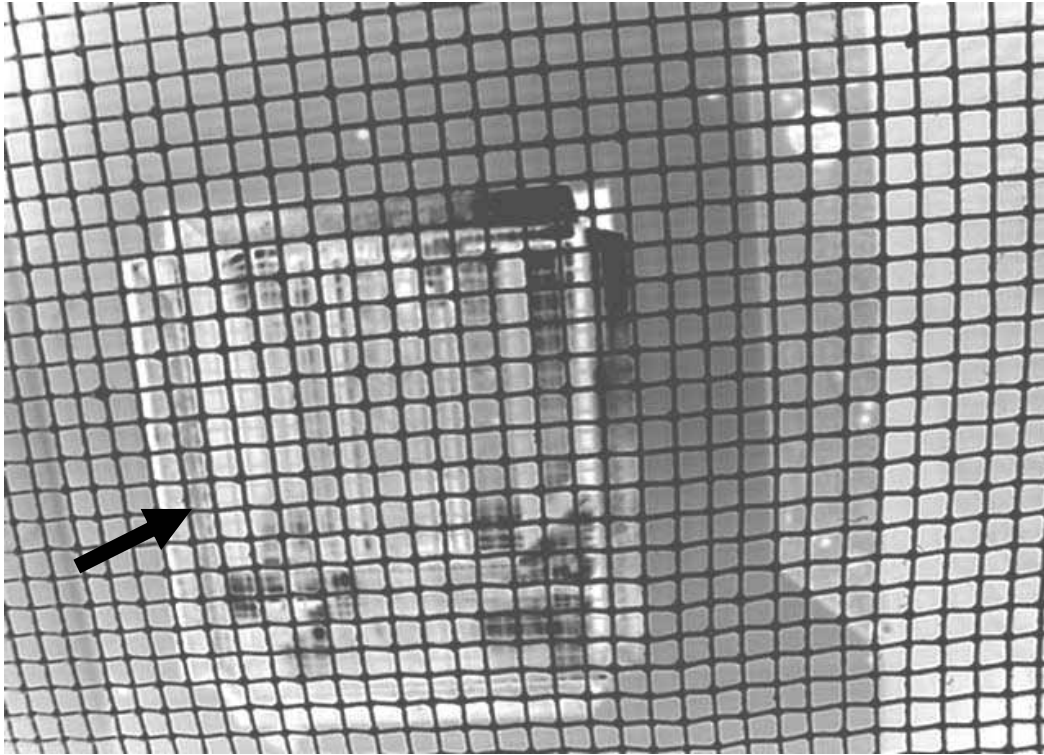
Coat Closet Exhaust Vent Noted in 1997 Addition Classrooms

Picture 8



Passive Door Vent Located on Coat Closet Door

Picture 9



Damper Noted Shut in Coat Closet Exhaust Ventilation Ductwork in 1997 Addition

Picture 10



Missing and Water-Stained Ceiling Tiles Noted in 1997 Addition

Picture 11



Univent Fresh Air Intake Vent on Exterior of 1997 Addition

Picture 12



Photocopiers Noted in First Floor Teacher's Workroom

TABLE 1

Indoor Air Test Results –Gordon Mitchell Middle School, East Bridgewater, MA – March 28, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	438	53	92					weather conditions: wet/rainy, wind-SSW-gusts 15-20 mph
Consumer Science I	587	73	48	10	yes	yes	yes	window open, 2 gas stoves, 2 ceiling mounted exhaust vents, 2 CT, door open
Art II	850	74	38	21	yes	yes	yes	kiln-local exhaust, univent off-activated by BEHA staff, 2 CT
Art I	600	73	38	0	yes	yes	yes	
Grade 4	680	76	39	11	yes	yes		
Boy's Restroom						yes	yes	passive door vent
Room 205	823	74	47	24	yes	yes	yes	vent louvers closed, exhaust vent partially blocked by table, cleaning products under sink
Room 208	1382	72	51	25	yes	yes	no	cold complaints from univent
Room 207	921	73	49	20	yes	yes	yes	4 plants
Room 209	914	75	46	27	yes	yes	yes	3 plants, door open

* ppm = parts per million parts of air
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results –Gordon Mitchell Middle School, East Bridgewater, MA – March 28, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 210	1100	75	45	23	yes	yes	yes	1 plant, temperature complaints
Room 211	1120	75	47	25	yes	yes	yes	univent return blocked by chairs/boxes, items on univent diffuser, door open
Room 212	1180	75	47	25	yes	yes	yes	
Room 213	1173	76	44	23	yes	yes	yes	door open
Room 214	1140	74	49	26	yes	yes	yes	chalk dust, cleaning products on table
Room 215				0	yes	yes	yes	4 CT, 7 plants
Room 216	1170	77	45	28	yes	yes	yes	4 CT, door open
Room 217	700	71	50	14	yes	yes	yes	window and door open, univent off
Room 218	1106	75	47	27	yes	yes	yes	8 plants, 1 CT
Gym E	900	71	47	27	no	yes	yes	ceiling mounted AHU, supply and exhaust off

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TABLE 3

Indoor Air Test Results –Gordon Mitchell Middle School, East Bridgewater, MA – March 28, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Gym W	887	70	49	27	no	yes	yes	ventilation off, heat complaints
Grade 6	608	72	49	3	yes	yes	yes	exhaust off, photocopier
Grade 6 Office				0	yes	yes	yes	exhaust off
Room 409	875	76	43	22	yes	yes	yes	exhaust off
Room 407	868	77	45	28	yes	yes	yes	window open, 2 plants, chalk dust
Room 405	1045	77	44	22	yes	yes	yes	chalk dust, door open
Boy's Restroom 2 nd floor						yes	yes	exhaust off
Room 408	1000	77	41	21	yes	yes	yes	
Room 403	1295	79	44	0	yes	yes	yes	exhaust off, door open, 19 occupants gone ~2 min.
Room 404	815	71	41	1	yes	yes	yes	25 occupants gone ~8 min., chemical ventilation hood, ventilation system deactivated due to noise, 4 plants

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TABLE 4

Indoor Air Test Results –Gordon Mitchell Middle School, East Bridgewater, MA – March 28, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Computer Science Room I	670	74	44	24	yes	yes	yes	6 CT
Library	650	73	40	3	yes	yes	yes	
Men's Restroom 2 nd floor						no	yes	
Women's Restroom 2 nd floor						no	yes	
Cafeteria	833	74	45	~200	yes	yes	yes	ventilation off
Band Room	841	71	48	28	no	yes	yes	6 CT, 2 CT/open utility holes in storage closet, wall exhaust partially blocked
Higgins Office	712	73	40	0	no	yes	yes	univent-ducted, IAQ complaints
Room 109	815	74	40	26	yes	yes	yes	window and door open, chalk dust
Room 111	814	71	43	25	yes	yes	yes	window open, 3 plants
Room 110	1300	72	50	25	yes	yes	yes	univent and exhaust off, 8 plants

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Relative Humidity - 40 - 60%

TABLE 5

Indoor Air Test Results –Gordon Mitchell Middle School, East Bridgewater, MA – March 28, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 113	1262	73	45	27	yes	yes	yes	univent off, exhaust blocked by trash can, 13 plants, door open
Room 112	1190	71	48	20	yes	yes	yes	univent off, exhaust weak, door open
Shop				0	yes	yes	yes	local exhaust provided for equipment, doors open
Room 309	1364	73	48	~25	yes	yes	yes	univent and exhaust off
Room 304	1043	72	46	2	yes	yes	yes	25 occupants gone ~5 min., supply and exhaust off
Boy's Restroom 1 st floor						no	yes	1 CT, possible mold growth
Room 101	1400	73	51	24	yes	yes	yes	4 plants
Room 103	1387	74	46	29	yes	yes	yes	chalk dust
Room 102	1550	75	51	~50	yes	yes	yes	double occupied, univent return blocked by bookcase
Room 105	1296	73	49	23	yes	yes	yes	exhaust weak, chalk dust
Hallway								wood shop odors

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TABLE 6

Indoor Air Test Results –Gordon Mitchell Middle School, East Bridgewater, MA – March 28, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 104	1223	71	52	24	yes	yes	yes	occupants in room ~5 min., door open
Room 107	1401	74	48	27	yes	yes	yes	dry erase board over univent, exhaust weak, 11 plants, chalk dust
Room 106	1225	72	52	27	yes	yes	yes	heat complaints
Room 108	1580	75	51	28	yes	yes	yes	exhaust blocked by file cabinet/waste basket
Grade 5- Inner Office	652	72	43	0	no	yes	yes	

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CT = water-damaged ceiling tiles

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